MODULE 4: EVALUATING ALTERNATIVES

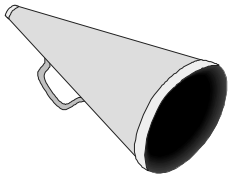
In this module we explore ways to evaluate alternatives for environmental aspects that you want to change. In Module 6 we will review how to write and implement operational controls for significant aspects where you are not evaluating alternatives. As examples of alternatives evaluations, we will show one project having a quick, low-cost solution and one requiring greater analysis and longer-term implementation: the examples of toner cartridges and press cleaning chemicals. The objectives from the end of Module 3 were as follows:

- Reduce the waste from used toner cartridges.
- Reduce the environmental impact of chemical wastes from press cleaning. The environmental aspect is vapors released to air during the press cleaning process and at the industrial laundry where used press wipers are sent. Identification of this significant aspect occurred when the laundry called the company and said they had received complaints from the local regulatory agency regarding solvent traced to the printer's press cleaning wipers. The information for this example comes from the DfE Program Lithography Case Study 1. (See DfE Program website for Case Study.)

This module will help you determine how to work toward the objectives you selected in Module 3. In some cases, this might

The DfE Program emphasizes the importance of evaluating an array of alternatives before determining appropriate action. The best solution may not be the most obvious and risk reduction, like pollution prevention, may save you money.

not be a difficult process. In others, however, the solution might not be obvious. For example, you may have identified the waste from the use of a chemical as a significant aspect and determined that alternative practices exist. You may have then set an objective of reducing the environmental impact from that chemical as it is used in your business processes. One alternative way to achieve that objective would be to target that chemical for replacement, but that may not be the best solution for your company. It is important, therefore, to consider other options for managing the environmental impact of that chemical as it is used by your company, as well as the option of replacement. This module will walk you through a process of evaluating options for substitution. It will also help you develop achievable targets having both environmental and economic advantages.



Screenprinters in the SGIA IEMS Pilot Project had this to say about the DfE method:

"The DfE method forces one to evaluate all aspects–health, safety, regulatory, environmental. The method helps you to make informed decisions.

"The process standardizes methods used to assess risk and resource efficiency. It makes it easier to compare "apples to apples." While some matters are still judgement calls, having a frame of reference to work within ensures that the standards used to make those calls are constant and logical."

Step 1: Define the Baseline

The baseline is your current chemical, activity or technology that is the source of the environmental aspect. The process map you developed in Module 1 is a convenient tool for defining boundaries of the baseline.

Usually it is fairly straightforward to determine at what point in the overall process the baseline begins and ends. The definition can make a big difference, however, in the scope of an alternatives evaluation and in the variety of alternatives examined. In our press cleaning example above, the baseline could be defined in different ways, depending on exactly how the environmental aspect is specified. If one identifies the

environmental aspect as vapors contaminating the work area, then the baseline would be use of the product producing the vapors and whatever ventilation hoods or personal protective equipment are used. If, however, the environmental aspect is identified as the regulated chemical discharges from the laundry when washing the press wipers, then the baseline becomes the chemical product used to clean presses and the work practices that leave large quantities of the solvent in the press wipers when they are sent to the laundry. In the first case, alternatives might include different chemical cleaning products and also different kinds of ventilation equipment and personal protective equipment. In the second case, alternatives would include products, work practices and methods of reducing solvent left in used wipers. Be sure to capture all you need when you define your baseline.

Step 2: Identify the Function

Next, define the function of the activity with which the significant environmental aspect is associated. Defining the function helps to broaden your perspective in developing alternatives because it allows you to step back from that specific part of the process and think holistically about how things might be done differently. Looking at earlier parts of the process will inform you about potential alternative practices. Defining the function often opens up opportunities that may be missed by focusing only on the process step. Here are two examples:

Internet Help

Visit the DfE website for more tools related to evaluating alternatives.

www.epa.gov/dfe

Example 1

Aspect identified: Waste from toner cartridges used in copier.

Baseline: Day-to-day copying activities in an office environment with no restrictions on use of the copier. Spent toner cartridges are discarded with office trash.

Function of toner cartridges: to deliver the chemicals to make clear copies.

Example 2

Aspect identified: air and water emissions from solvent used for press cleaning.

Baseline: Manual cleaning of press using a chemical press cleaner (a blend of acetone, toluene, methyl ethyl ketone, and isopropyl alcohol) and cloth wipers to wipe down the press, with no restrictions on the amount of cleaner or number of wipers used. Chemicals and soiled wipers are kept in uncovered containers during the work day and closed containers after work hours. Waste ink/solvent mixture is collected in drums and disposed of as hazardous waste. Wipers are collected and sent to laundry.

Function of press wash: to ensure good quality printing by thoroughly cleaning the press during and after the printing process.

Step 3: Develop a List of Alternatives

The important question to ask is how this function could be accomplished in other ways that might prove to be environmentally preferable, while still meeting cost and performance concerns. Different levels and kinds of alternatives should be considered. For example:

- Substitute products
- Reduce product use, through technology changes and improved work practices
- Improve treatment technologies
- Improve disposal technologies

Example 1: List the alternatives for reducing the waste from used toner cartridges

- First, are there substitute products that could be used in place of toner cartridges? Probably not, given current technology and the fact that the toner cartridge specifications are required by the make and model of the printer.
- Is there a way to reduce the use of the toner cartridges, thereby reducing the waste product? By defining copier needs, the quantity of copying could possibly be reduced by encouraging the use of electronic transfer of information within the company, in place of distributing paper copies.

- Improved treatment technologies — does not apply for this example.
- Improved disposal technologies. The disposal alternatives include throwing in the trash or recycling.

Example 2: List the alternatives to the current press wash process

- Substitution: First ask the question, is there any way to achieve the required product quality with the use of less or no press cleaning solution? You may consider substitutions in another part of the process, such as the type of ink, so that less or different press cleaning solution could be used. Or, you could also consider substituting the press wash solution for a less volatile cleaner.[3] Such substitution may require other process changes to work. You could also consider using disposable cleaning wipers, which would eliminate the releases and exposures at the laundry. In doing so, however, you may create a problem of hazardous waste at the landfill, thereby merely transferring the problem from one location to another rather than solving it.
- Reducing use of the product: reduction in use of the press wash solution might be brought about by scheduling jobs to require less cleaning (e.g., heavy coverage jobs *after* light coverage; dark colors *after* light colors), or by implementing inventory control procedures that discourage operators from using more wash than necessary (e.g., by

☞ Tip

Think broadly when developing alternatives. Sometimes an alternative that is upstream or downstream from your process will produce better results than will a change of chemicals or another in-process change.

[3] "Volatile" means that the substance evaporates easily.

limiting the amount of wash kept at press-side). In addition, a study could be made to determine what methods are used by press operators who use the least solvent. Their methods could be used to train others.

- Responsible recycling/reuse: Possibly the waste press wash solution could be reused one or more times; if not on the press, then in other clean-up applications.
- Improved treatment technologies: Soiled wipers can be run through a centrifuge to capture excess solvent prior to being sent to the laundry, but fire regulations should be consulted to ensure this doesn't impose a fire hazard.
- Improved disposal technologies: What are alternatives for disposal? Sending the wipers to the laundry; extracting waste solvent from the wipers and reusing the solvent for other cleaning jobs, then sending it to be burned as a fuel; using disposable wipers and throwing them in the trash.

Worksheet 4-1 will help you organize the functions and alternatives for your evaluation. Create your own worksheet from the significant environmental objectives you selected in Module 3. Some of these boxes can be filled out by brainstorming within the team working on the IEMS, but some will require further work before they can be completed. Some additional sources of information include chemical product suppliers, machinery manufacturers and suppliers, workers on the line, trade associations, technical magazines associated with your business, or other businesses like yours. You may be surprised at how much information you will uncover. One way to proceed might be to assign each member of the team one area of information to

collect, and then have them use it to fill in the chart at the next team meeting. It's important to collect as many ideas as possible and then narrow down your list of alternatives to evaluate. By keeping your mind open in your initial brainstorming you may uncover worthwhile alternatives that are not obvious.

Worksheet 4-1:* Potential Alternatives

Significant Environmental Aspect: Waste toner cartridges
Baseline: Spent toner cartridges are discarded in trash.
Function: Provide ink for duplicating

	Current Practices	Potential Alternatives
Products	Toner Cartridges	N/A
Technologies	Paper	More electronic media use would reduce need for toner cartridges
Work Practices	Unlimited copier use	More careful about use of printing could reduce quantity of toner needed
Recycling/ Reuse	Discard in trash	Follow manufacturer's directions to recycle
Treatment	N/A	N/A
Disposal	See Recycling/Reuse Above	See Recycling/Reuse Above
Contact Person:		Date Completed:

* Document these results in Section AE of the *Company Manual Template.*

Worksheet 4-1:* Potential Alternatives

Significant Environmental Aspect: Press washing
Baseline: Manual cleaning of press using a chemical press cleaner (a blend of acetone, toluene, methyl ethyl ketone, and isopropyl alcohol) and cloth wipers to wipe down the press, with no restrictions on the amount of cleaner or number of wipers used. Chemicals and soiled wipers are kept in uncovered containers during the work day and closed containers during after hours. Waste ink/solvent mixture is collected in drums and disposed of as hazardous waste. Wipers are collected and sent to laundry.
Function: Provide crisp print quality by effectively cleaning press.

	Current Practices	**Potential Alternatives**
Products	Prod. A (current)	Prod. B Prod. C (Special formulation)
Technologies	Current blankets, Cloth wipers, Current ink	Different blankets; Disposable wipers; Different ink
Work Practices	Work Practice A	Work Practice B Work Practice C
Recycling/Reuse	Leave solvent in wipers	Reuse of solvent for other clean up.
Treatment	Leave solvent in wipers	Extraction of solvent from wipers
Disposal	Laundry	Trash Drain Hazardous Waste
Contact Person:		Date Completed:

* Document these results in Section AE of the *Company Manual Template*.

Step 4: Set the Scope of the Evaluation

You have now reached a critical decision point in your evaluation of alternatives. You must decide how detailed an evaluation is feasible. Keep in mind the cost of performance testing as you choose alternatives to evaluate.

When you have selected alternatives to evaluate, place these alternatives in the appropriate parts of your process map developed in Module 1. If necessary, create new segments of the process map so that you can show how the alternative fits into your process.

The following worksheets show the kinds of information that should be collected for each set of alternatives to yield a decision about which option would be the most feasible, both technically and economically, for your company to reduce its environmental impact. These tables will also give you the information needed to frame specific measurable targets for your environmental programs.

Each alternative requires developing several kinds of information:

- health,
- safety,
- environmental effects,
- performance capabilities,
- cost,
- effects on resource use, and

- regulatory concerns.

This information will help you integrate human health and environmental concerns into your usual decision-making criteria of performance and cost. The following worksheets are designed to help you organize this information in a way that makes comparisons easier. The following sections take you step by step through the evaluation process.

Example 1

To develop alternatives on copier toner cartridges, your company would conduct brainstorming sessions about the options for more use of electronic media within your office and otherwise reducing the need to use the copier in your office activities. Developing ways to cut down on copying can extend the life of toner cartridges and reduce the volume requiring disposal. Steps that seem appropriate and desirable can be recorded and incorporated into your targets. You could establish a dual goal of reducing the volume of copying and 100% recycling of toner cartridges. Module 6 explains how to develop operational controls to ensure reduced environmental impact. Module 7 explains how you can make your goals into an "environmental project."

Most of the alternatives for Example 1 do not require substantial changes and would be implemented by designing guidelines for use and maintenance of the copier, i.e., operational controls. While these alternatives could be evaluated using the steps below, we will not include this example in the sample

worksheets. Example 2 provides a more thorough example of the evaluation process, and we will focus on that.

Example 2

To develop alternatives to reduce air and water emissions caused by press washing, a full evaluation would require research for each of the alternatives identified. (You may view such an extensive analysis on the DfE Website. See Appendix G.) You may not have the resources to do a full evaluation at this time, but you can research any of the alternatives you choose. The point of identifying a range of alternatives is to let you choose the options to evaluate with full knowledge of the range available to you, rather than in response to preconceptions. For example, you could choose to evaluate one set of alternatives now and another set at a later date as part of a continuing effort.

Step 5: Evaluate Potential Human Health and Environmental Effects of Alternatives [4]

Worksheet 4-2 through 4-6 shows the kind of information needed to evaluate the environmental effects of alternative products. Refer to Module 3 for explanation of the elements. Worksheets 4-2 through 4-6 correspond to worksheets 3-1 through 3-5 in Module 3.

☞ Tip

The worksheets presented in this section are designed to be "one-size-fits-all." Unfortunately, not all evaluations will be the "same size." Adapt these worksheets to suit the needs of your evaluation.

[4] All information in worksheets is created for purposes of illustration and does not represent real data.

Worksheet 4-2:[a] Alternatives Evaluation: Health, Safety and Environmental Potential Effects Information

Baseline: Manual cleaning of press using a chemical press cleaner (a blend of acetone, toluene, methyl ethyl ketone, and isopropyl alcohol) and cloth wipers to wipe down the press, with no restrictions on the amount of cleaner or number of wipers used. Chemicals and soiled wipers are kept in uncovered containers during the work day and closed containers during after hours. Waste ink/solvent mixture is collected in drums and disposed of as hazardous waste. Wipers are collected and sent to laundry.

Significant Environmental Aspect: Press cleaning

Alternative	**Information Sources**	**Regulatory Data:** [b] **Carcinogen? OSHA Exposure limit? Volatile Organic Compound (VOC)? Toxics Release Inventory (TRI)?**	**Human Health Effects by Pathways Acute and Chronic** [c]			**Com-ments**	**Effects on Wildlife and Other Environmental Effects** [d]			**Worker Safety** [e]	**Rank**	
			Inhalation	**Dermal**	**Oral**		**Air**	**Water**	**Land**		**Human** [f]	**Env**
Products Baseline: Blend A	MSDS	Greater than 50% VOC —- all chemicals in blend										
acetone 25%		OSHA PEL, 8H TWA: 1000 ppm, burn in chemical incinerator, EPA FIFRA pesticide, Calif Prop 65 Repro Haz	irritant, liver, kidney,	irritant, eye damage			may contribute to smog	?	?	highly flammable, vapor may flash back, explosive, combustive, may produce carbon monoxide or carbon dioxide	H	?

toluene 25%		Burn in incinerator, OSHA PEL 8H TWA 200 ppm, SARA 313 reporting, Calif Prop 65 developmental toxicity	toxic, liver, kidney, destructive to tissues, lung irritation, chest pain, edema, possibly fatal, abortion, changes in bone marrow	toxic, extremely irritating	toxic	Effects may be increased by alcohol consumption	may contribute to smog	?	?	Highly flammable, combustive, protect from moisture	H	?
MEK 25%		burn in chemical incinerator, EPA FIFRA pesticide, OSHA PEL 8H TWA 200 ppm, TSCA 8a rule, SARA 313 reporting	irritant respiratory system, central nervous system depression, nausea, dizziness, headache, gastro-intestinal, narcotic effect	irritant eyes, skin, dermatitis			may contribute to smog	?	?	Highly flammable, combustive, protect from moisture	M-H	?
isopropyl alcohol 25%		may be disposal regulations	irritant nose & throat, central nervous system depression, vomiting, headache, coma, death	irritant eye, corneal burns, dermatitis	large amounts: headache, nausea, vomiting, unconsciousness, death		may contribute to smog	?	?	Flammable, reactive, may produce carbon monoxide and carbon dioxide	H	?
Special blend B: vegetable ester	DfE Litho-graphy Project	Less than 30% vocs No regulations	Low	Low	Low		?	no aquatic toxicity	?	No concerns	L	L
Technologies												
Work Practices												

Recycling/ Reuse												
Treatment Centrifuge used to extract solvent from wipers, using Blend A	DfE Lithography Project, Case Study 1	Possible regulation about using centrifuge, all other regulations applying to Blend A above	Same as Blend A	Same as Blend A	Same as Blend A	Same as Blend A	Same as Blend A	Same as Blend A	Same as Blend A	Same as Blend A, also will need an explosion proof centrifuge	H	H
Disposal												
Contact Person:			Date Completed:									

a See Section AE of the *Company Manual Template.*

b Most Information for this column can be found on the MSDS.

c Partial information for these columns might come from the MSDS, but other resources may be needed. In particular, acute effects are usually reported on MSDS sheets. Chronic effects are sometimes on MSDS sheets, but often will have to be found elsewhere.

d MSDSs usually do not include environmental effects.

e There may be information on the MSDS that would be useful for preparing your emergency preparedness plan.

f This rank is based on the potential effects of the chemical and not on the dose required to obtain those effects. For example, a person can drink a certain amount of Scotch. Drinking a large quantity of Scotch, however, can be lethal. Therefore dose does make a difference ultimately in making a judgment. However, one can still make a qualitative ranking about whether Scotch, cola, water, milk or juice have beneficial or negative impacts. For more discussion of the role of “dose” see the Hazard Guide on the DfE web site.

Note: For more information on risk related data, including methods for interpreting quantitative toxicity values, refer to the risk Guide provided on the DfE Program website. The data on this table were constructed for purposes of illustration and do not represent real data.

Worksheet 4-3: Alternatives Evaluation: Exposure to Chemicals and Materials

Baseline: Manual cleaning of press using a chemical press cleaner (a blend of acetone, toluene, methyl ethyl ketone, and isopropyl alcohol) and cloth wipers to wipe down the press, with no restrictions on the amount of cleaner or number of wipers used. Chemicals and soiled wipers are kept in uncovered containers during the work day and closed containers during after hours. Waste ink/solvent mixture is collected in drums and disposed of as hazardous waste. Wipers are collected and sent to laundry.

Significant Environmental Aspect: Press cleaning

Alternative Products	Quantity* Used per time period	Exposure Time		Personal Protective Equipment (PPE)	Pathway		Rank Exposed Groups		
		Duration**	Frequency		Human: Inhalation, Dermal, Oral	Environment: air, water, land	Workers	Community	Envir-onment
Baseline: blend A	24 oz. Per day for cleaning press	10 min. for cleaning all day for wipers in open bins	5 times per day for cleaning				H w/o PPE	H (laundry releases)	M
acetone				face shield, chemical safety goggles, chemical gloves, mechanical exhaust, NIOSH-OSHA respirator	All for workers, inhalation for community				
toluene	Same	same	same	above, plus chemical fume hood	All for workers, inhalation for community	air, water			
MEK	same	same	same	same as acetone	All for workers, inhalation for community	air, water			

isopropyl alcohol	same	same	same	half mask respirator, gloves, local exhaust, safety goggles, rubber apron, boots, impervious clothing	All for workers, inhalation for community	air, water			
Blend B: vegetable ester	12 oz per day for cleaning press	10 min. for cleaning, all day for wipers in open bins	5 times per day for cleaning	none	all	water	M w/o PPE (less due to less volume used and less volatile mix)	M	L
Technologies									
Work Practices									
Recycling/Reuse									
Treatment: Centrifuge (assuming Blend A)	8 oz recovered per day - reduce environmental releases by 1/3	10 min while putting wipers in centrifuge	1 time per day	gloves	inhalation, dermal	n/a	M w/o PPE	M (possibly some fumes from venting centrifuge)	L
Disposal									
Contact Person:					Date:				

*If ingredient in chemical product, use quantity of chemical not product, i.e., apply the percentage that the ingredient makes up of the product.

**How many minutes or hours per day is the chemical or material used?

Note: All data are for purposes of illustration and do not represent real data.

Worksheet: 4-4: Alternatives Evaluation: Community Issues

Significant Environmental Aspect: Press Cleaning

Alternative	**Community Issues (List)**	**Rank**
Products	no additional issues	
Technologies		
Work Practices		
Recycling/Reuse		
Treatment		
Disposal		
Contact Person:		Date:

Worksheet: 4-5: Alternatives Evaluation: Natural Resource Use

Significant Environmental Aspect: Press Cleaning

Alternative	**Natural Resources Used (List)**	**Rank**
Products	no additional issues	
Technologies		
Work Practices		
Recycling/Reuse		
Treatment		
Disposal		
Contact Person:		Date:

Worksheet 4-6:[a] Alternatives Evaluation: Criteria to Determine Environmental Impact

Baseline: Manual cleaning of press using a chemical press cleaner (a blend of acetone, toluene, methyl ethyl ketone, and isopropyl alcohol) and cloth wipers to wipe down the press, with no restrictions on the amount of cleaner or number of wipers used. Chemicals and soiled wipers are kept in uncovered containers during the work day and closed containers during after hours. Waste ink/solvent mixture is collected in drums and disposed of as hazardous waste. Wipers are collected and sent to laundry.

Significant Environmental Aspect: Press Cleaning

Alternative	Regulatory Concerns	Chemical and Material Risk			Worker Safety	Other Community Issues:[c]	Natural Resources[d]	Overall Ranking	Preferred Alternative? Y/N
		Worker Eff/Exp[b]	Community Eff/Expb	Environment Eff/Exp[b]					
Products:									
Blend A (Baseline)	H	H/H	H/H	?/M	H	n/a	n/a	H	
Blend B	L	L/M	L/M	L/L	L	n/a	n/a	L	yes
Technologies									
Work Practices									
Recycling/Reuse									
Treatment: Centrifuge	M	H/M	H/M	?/L	H	n/a	n/a	M-L	yes
Disposal									
Contact Person:				Date Completed:					

[a] Corresponds to SEA-01 in *Company Manual Template*.
[b] Effects/exposure
[c] Noise, traffic, light, odor.
[d] Include such items as resource use, solid waste, energy use.

Step 6: Evaluate the Performance of Alternatives

Evaluating the performance of your alternative chemical products requires several steps, as described below. Performance evaluations can be expensive to perform. Consider the cost of the evaluation when deciding how many and what kind of alternatives to test.

Describe the baseline. The baseline is the standard chemical, activity, or technology that is currently used. The baseline also includes the boundaries of the baseline, its process steps and how they are performed. This ensures that (1) a similar process is used to evaluate the performance of the baseline and alternatives where possible, or (2) when a different process is used due to the nature of the alternative (e.g. technology), differences will be noted and understood. The alternatives will then be compared to this baseline.

Example: The baseline for press washing is manual cleaning of press using a chemical press cleaner (a blend of acetone, toluene, methyl ethyl ketone, and isopropyl alcohol) and cloth wipers to wipe down the press, with no restrictions on the amount of cleaner or number of wipers used. Chemicals and soiled wipers are kept in uncovered containers during the work day and closed containers during after hours. Waste ink/solvent mixture is collected in drums and disposed of as hazardous waste. Wipers are collected and sent to laundry.

Identify the most important performance traits for the selected process area. Some sample performance traits include the following: how well does it work, how long does it take, how easy is it to use, and how easy is it to install?

Example: The most important performance traits for press wash are that it work quickly to cut ink, require minimal wiping to remove any oily residue, dry quickly, and not adversely affect print quality.

☞ Tip

Cost data for your cost evaluation should be collected during the performance evaluation There may be more uncertainty in the cost data if you wait to develop it until after the performance evaluation. See Step 8 for information on what kind of data will be needed for your cost evaluation.

☞ Tip

See Appendix C for sample performance evaluation worksheets from the DfE Printing Project.

Determine how the alternatives will be compared with the baseline. One example of a quantitative comparison is measuring the time it takes to complete a task. One example of a qualitative comparison is using a scale, such as ++ representing "much more favorable than the baseline."

Example: We will use a comparison scale from -2 to +2, where -2 represented "much less favorable than the baseline," +2 represented "much more favorable," and a 0 represented "no difference with the baseline."

Select the operating conditions for testing the baseline and alternatives and conduct the evaluation. The operating conditions should be realistic and consistent for the baseline and alternatives. If you cannot test an alternative at your facility (e.g., new equipment), have the supplier provide off-site service or performance test data. Conditions should be as similar as possible for each test, or the results will not be comparable. Examine work practices as well to ensure similar application from test to test. Other elements that may affect testing include room temperature and humidity. Make a list of what things might affect your test results and try to make sure that they are similar for each test.

Example: Evaluate the baseline and alternatives using the same size printing run, the most commonly used ink formulation, the same application procedures, and the same printed image.

An evaluation example is shown in Worksheet 4-7.

Worksheet 4-7:* Performance Comparison of Alternatives

Significant Environmental Aspect: press cleaning
Baseline: Manual cleaning of press using a chemical press cleaner (a blend of acetone, toluene, methyl ethyl ketone, and isopropyl alcohol) and cloth wipers to wipe down the press, with no restrictions on the amount of cleaner or number of wipers used. Chemicals and soiled wipers are kept in uncovered containers during the work day and closed containers during after hours. Waste ink/solvent mixture is collected in drums and disposed of as hazardous waste. Wipers are collected and sent to laundry.
Function: ensure crisp print quality by effectively cleaning press

	How well it works	**Time**	**Ease of use**	**Overall Performance Evaluation**
Blend A (baseline)	0	0	0	0
Product B	0 (Did not show much difference from baseline)	0	0	0
Technologies				
Work Practices				
Recycle/ Reuse				
Treatment: Centrifuge to recover Blend A	+ (demonstrates that worked well, but is not comparable to products above)	"+"	"+"	"+" works well to recover solvent
Disposal				
Contact person:			Date Completed:	

*Document these results in Section AE of the *Company Manual Template*.

Step 7: Evaluate what regulations may be triggered by using each alternative

For each alternative being considered, make sure you understand the applicable regulations. This may influence your choice of alternatives. Identify what management controls might be required by these regulations. Also consider what additional cost might be attributed to the regulation. Some of the costs associated with using a product or process may be attributable to a regulation triggered by using that product or process. These would be the regulatory cost and should be included on Worksheets 4-8 and 4-9.

Worksheet 4-8:* Regulatory Comparison of Alternatives				
Alternative	**Applicable Regulations**	**Required Controls**	**Regulatory Cost Items [1]**	**Overall Regulatory Concerns Evaluation**
Product Blend A	same as Worksheet 4-2	same as Worksheet 4-3	SARA reporting, PPE, Chemical fume hoods, fire controls	H
Blend B	none	none	none	L
Technologies				
Work Practices				
Recycle/ Reuse				
Treatment Centrifuge	possible local fire regulations	May not be allowed		H
Disposal				
Contact Person:			Date Completed:	

*Document results in Section AE of the *Company Manual Template.*

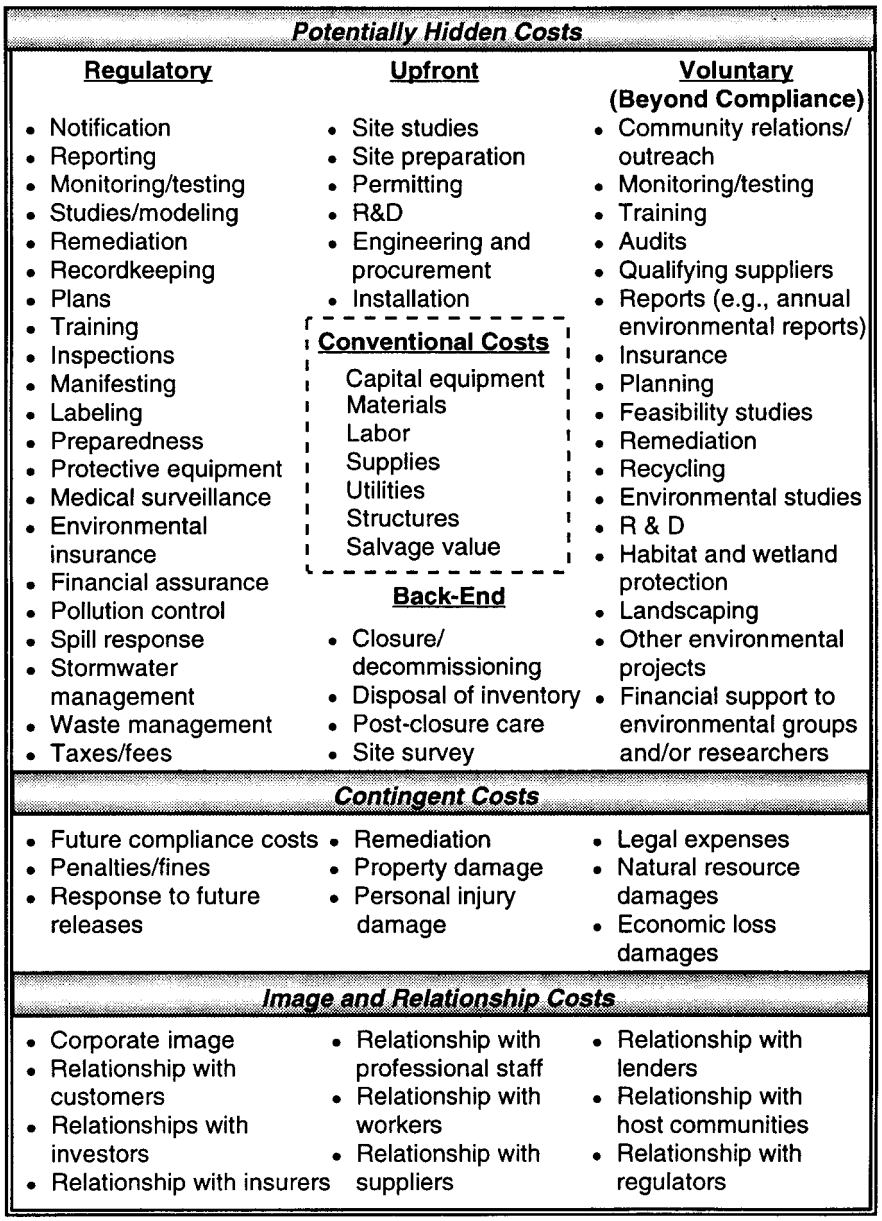
[1] Include: paperwork triggered, reporting requirements, cost of controls, personal protective equipment and any other costs that may be attributed to regulations associated with using that product or process. It is not necessary to quantify on this table. See Step 8 and Appendix F for more ideas.

Step 8: Evaluate the cost of the baseline and alternatives

Determine the cost of each alternative, including: raw materials, labor, disposal costs, (all from Step 6) and regulatory costs (from Step 7). Include all the cost categories in the baseline and the alternatives. It's important to document all costs, even those that are the same for the baseline and for the alternatives. Documenting all costs gives you a reference later to answer questions and to support further evaluations. Figure 4-a shows possible costs associated with regulations that may be hidden in overhead in your company's accounting system. Be sure to include these hidden costs when completing the worksheets.

See Appendix F for more discussion of environmental cost accounting.

Figure 4-a. Examples of Environmental Costs Incurred by Firms*



*Taken from "An Introduction to Environmental Accounting as a Business Management Tool: Key Concepts and Terms," EPA 742-R-95-001.

Evaluating the cost of the baseline and alternatives requires several steps, as described below.

Annual operating costs

Collect annual operating costs for your baseline and alternative. Use Worksheet 4-9a to help you collect cost information. Review Worksheets 4-2 and 4-8 to assist you in evaluating environmental costs. Be as thorough as possible when considering costs, but don't worry about how you classify costs. For example, you may wish to consider personal protective equipment as a regulatory compliance cost, especially if its use is required by regulations. Alternatively, you may wish to classify all protective equipment as "materials." Use Worksheet 4-9a to record operating costs.

Worksheet 4-9a: Annual Operating Costs

Significant Environmental Aspect: Press Cleaning

Baseline: Manual cleaning of press using a chemical press cleaner (a blend of acetone, toluene, methyl ethyl ketone, and isopropyl alcohol) and cloth wipers to wipe down the press, with no restrictions on the amount of cleaner or number of wipers used. Chemicals and soiled wipers are kept in uncovered containers during the work day and closed containers during after hours. Waste ink/solvent mixture is collected in drums and disposed of as hazardous waste. Wipers are collected and sent to laundry.

Alternative	**Materials**	**Direct Labor**	**Utilities**	**Waste Management**	**Regulatory Compliance**	**Insurance**	**Future Liability**	**Total Operating Costs**
Products Blend A: Baseline	$24,320	$2,075	n/a	$7,000	$2,100	$0	possible medical suits	$35,495
Blend B	$6,320	$2,500		$0	$0	$0		$8,820
Technologies								
Work Practices								
Recycle/ Reuse								
Treatment: Centrifuge	n/a	$420	$200	$6,200	$2,100	$200	$0	$9,120
Disposal								
Contact person:					Date:			

Potential Annual Revenue Effects

Environmental projects may save you money not only by reducing your costs, but also by generating revenues. For example, an alternative may increase your product throughput because the activity takes less time to complete, or product quality may be improved enabling you to sell more of your product. The alternative may also let you recover materials previously disposed of, and generate revenues through sales of the reclaimed material (such as recovering metal scrap which can be sold to scrap dealers). These annual revenue effects should be considered using Worksheet 4-9b. If these potential revenues are difficult to quantify, you can consider them qualitatively in your evaluation by making a note in the last column of Worksheet 4-9d. In general, a reduction in materials needed would show up on Worksheet 4-9a: Annual Operating Costs. In this example, the reduction in press cleaning solvent needed due to switching to a less volatile blend (much less lost through evaporation during use) does show up in the first column of Worksheet 9-a. The revenue effects shown in Worksheet 4-9b are caused by reusing the solvent recaptured by the centrifuge for other cleaning operations (not press cleaning). In other words, the centrifuge saves on the purchase of other kinds of cleaning solvents than the ones being considered for press cleaning.

Worksheet 4-9b: Potential Annual Revenue Effects

Significant Environmental Aspect: Press Cleaning

Baseline: Manual cleaning of press using a chemical press cleaner (a blend of acetone, toluene, methyl ethyl ketone, and isopropyl alcohol) and cloth wipers to wipe down the press, with no restrictions on the amount of cleaner or number of wipers used. Chemicals and soiled wipers are kept in uncovered containers during the work day and closed containers during after hours. Waste ink/solvent mixture is collected in drums and disposed of as hazardous waste. Wipers are collected and sent to laundry.

Alternative	**Product Throughput**	**Product Quality**	**Reuse of or Sales of Recovered Materials**	**Total Revenue Effects**
Products: Blend A or B	none	none	none	0
Technologies				
Work Practices				
Recycle/Reuse				
Treatment: Centrifuge	0	0	$34,000	$34,000
Disposal				
Contact Person:		Date:		

Initial Investment Costs

Collect initial investment costs for each alternative. If any of your alternatives will require an investment in new equipment, you will need to consider these costs. These not only include capital costs, but also other one-time costs accompanying your investment, such as installation costs or new equipment training. Use Worksheet 4-9c to help you collect these costs.

Worksheet 4-9c: Initial Investment Costs*

Significant Environmental Aspect: Press Cleaning

Baseline: Manual cleaning of press using a chemical press cleaner (a blend of acetone, toluene, methyl ethyl ketone, and isopropyl alcohol) and cloth wipers to wipe down the press, with no restrictions on the amount of cleaner or number of wipers used. Chemicals and soiled wipers are kept in uncovered containers during the work day and closed containers during after hours. Waste ink/solvent mixture is collected in drums and disposed of as hazardous waste. Wipers are collected and sent to laundry.

Alternative	**Purchased Equipment**	**Utility Systems/ Connection**	**Planning/ Engineering**	**Site Preparation**	**Construction/ Installation**	**Start-up/ Training**	**Permitting**	**Other****	**Total Inv. Costs**
Products Blend A or B	none	none	none	none	none	none	none	none	none
Technologies									
Work Practices									
Recycle/Reuse									
Treatment: Centrifuge	$15,000	0	$2,000	$500	0	$200	Depends on local regulations	0	$17,700
Disposal									
Contact Person:					Date:				

*Typically there are no investment costs for your “business as usual” baseline.

**"Other" costs potentially include land or building purchases, contingency to cover unforeseen expenses, and investment in initial inventory (also known as working capital). For further description of these costs, see Appendix F.

If a change in your processes or activities will affect your costs and savings over many years, the analysis should look at long term costs and savings. A critical component of assessing a project where costs and savings may occur over several years is incorporating the notion that the value of money changes over time – commonly called the "time value of money." Most businesses prefer to have money sooner rather than later. If you have money today, you have the opportunity to use it now to grow your business. See Appendix F for more information on how to obtain the net present value of your initial investments, if you wish to make that calculation.

☞ Tip

Remember that your accountant can assist you in making these calculations.

Cost Comparison

Use Worksheet 4-9d to list and rank the results of each cost table.

Worksheet 4-9d: Cost Comparison of Alternatives

Significant Environmental Aspect: Press Cleaning
Baseline: Manual cleaning of press using a chemical press cleaner (a blend of acetone, toluene, methyl ethyl ketone, and isopropyl alcohol) and cloth wipers to wipe down the press, with no restrictions on the amount of cleaner or number of wipers used. Chemicals and soiled wipers are kept in uncovered containers during the work day and closed containers during after hours. Waste ink/solvent mixture is collected in drums and disposed of as hazardous waste. Wipers are collected and sent to laundry.

Alternative	**Total Operating Costs**	**Total Investment Costs**	**Annual Revenue Effects**	**Rank**
Products Blend A Blend B	 $35,495 $8,820	 $0	 $0	 H L
Technologies				
Work Practices				
Recycle/Reuse				
Treatment: Centrifuge	$9,120	$17,700	$34,000	L
Disposal				
Contact Person:			Date:	

Document results in Section AE of the *Company Manual Template.*

Step 9: Evaluate Results

Use Worksheet 4-10 to compare performance, regulatory considerations, cost, and environmental effects for alternatives.

Worksheet 4-10:* Evaluation of Alternatives

Significant Environmental Aspect: Press Cleaning

Baseline: Manual cleaning of press using a chemical press cleaner (a blend of acetone, toluene, methyl ethyl ketone, and isopropyl alcohol) and cloth wipers to wipe down the press, with no restrictions on the amount of cleaner or number of wipers used. Chemicals and soiled wipers are kept in uncovered containers during the work day and closed containers during after hours. Waste ink/solvent mixture is collected in drums and disposed of as hazardous waste. Wipers are collected and sent to laundry.

Alternative	Performance Rank [1]	Regulatory Considerations Rank [2]	Cost Rank [3]	Environmental Effects [4]	Overall Evaluation[5]
Chemical Product A (current baseline)	0	H	H	H	Poor due to effects
Product B	0	L	L	L	Good due to effects & cost
Technologies					
Work Practices					
Recycle/Reuse					
Treatment: Centrifuge	"+"	H	L	M-L	Good due to effects & savings
Disposal					
Contact Person:			Date Completed:		

*Document results in Section AE of the *Company Manual Template*.

[1] Take from Worksheet 4-7 Performance Comparison of Alternatives.

[2] Take from Worksheet 4-8 Regulatory Comparison of Alternatives.

[3] Take from Worksheet 4-9d Cost Comparison of Alternatives.

[4] Take from Worksheet 4-4: Criteria to Determine Environmental Impact.

[5] Rank the desirability of each alternative. This is a judgment call.

Note: For more information on the methodology for comparing alternatives, refer to both the DfE Website and the *Cleaner Technologies Substitutes Assessment, A Methodology Resource Guide*, DfE, U.S. EPA 744-R 95-002, Dec. 1996.

Interpretation of Results

Performance

The rank of “0" for product A reflects that it is the baseline. The rank of “0" for product B indicates that it’s performance is very similar to the baseline. The + shown for the centrifuge shows that it performs well, but is not directly comparable to the products above.

Regulatory Considerations

Ranks show that product A has many regulations associated with the chemicals it contains, but product B chemicals have little or not regulations. The centrifuge is rated high because some states have regulations that may prohibit the use of centrifuges for recovering solvent from wipers. Also, the explosive nature of Product A ingredients would affect the type of centrifuge used. If product B were used with the centrifuge, the regulatory concern might not apply.

Cost

The rankings show the high cost associated with using product A compared to the low cost of using product B. In addition, the low cost rank for the centrifuge reflects the cost savings affected by re-using reclaimed solvent.

Environmental Effects

The high rank for product A reflects the serious impact of the chemicals contained in it, while the low score for product B reflects the low impact of that product’s chemicals. The M-L rank for the centrifuge reflects the reduction in use of solvent with some continuing exposure to the solvent for workers who transfer the wipers from bins to the centrifuge. There would also be some community exposure from venting the centrifuge out doors. In addition, it reflects the concern with the possibility of explosion of the centrifuge while extracting these solvents.

Conclusion

From both a cost and environmental perspective, switching to product B and using the centrifuge would make sense.

Remember, like all other aspects of your IEMS, evaluating SEAs and alternatives is an ongoing process. What you cannot accomplish this year, you can plan on doing next year. Take it step by step to avoid being overwhelmed.